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ABSTRACT

Studies were made between performance on tests of mental abilities and concept learning tasks; it is pointed out that the researcher is usually confronted with administering large batteries of tests of mental abilities and then analyzing his results with cne of the factor analytic techniques. An information process analysis of tests of mental abilities and concept learning led Costello and Dunham (1971) and Costello (1971) to postulate that three intellectual processes underlie performance on these two types of tasks. After testing, the process measures were found to highly correlate with performance on several tests of mental abilities. Using errors on the concept learning problems as a dependent variable, the following types of relationships should exist: (1) Ss supplied with hypothesis information should perform better on concept learning tasks; (2) There should be a significant treatment group by Hypothesis Generation (HG) interaction, and (3) There should be a significant HG by Hypothesis Evaluation (HE) interaction. Introductory educational psychology students were administered six intellectual process measures. All Ss worked two concept learning problems and each Ss worked one practice problem and one experimental problem. Two one-hour sessions were used to collect the test and concept learning data. The scores of the six process measures were factor analyzed by the principal-axis method. An analysis of variance was performed. Results revealed a significant treatment main effect, a significant interaction between HE and HG variables. (CK)

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HYPOTHESIS GENERATION, EVALUATION, AND MEMORY ABILITIES IN ADULT HUMAN CONCEPT LEARNING[1]

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In studying the relationship between performance on tests of mental abilities and concept learning tasks, the researcher is usually confronted with administering large batteries of tests of mental abilities and then analyzing his results with one of the factor analytic techniques. Recent work by Costello and Dunham (1971) and Costello (1971) seems to indicate that the administration of large batteries of tests of mental abilities may be unnecessary. Furthermore, their work indicates that this relationship may be studied more directly by analyzing the information processing requirements of the two tasks in order to determine their common information processing requirements. Such information processing requirements may

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then be experimentally manipulated and the consequences of such manipulations observed in the problem solving behaviors of human Ss.

An information processing analysis of tests of mental abilities and concept learning tasks led Costello and Dunham (1971) and Costello (1971) to postulate that three intellectual processes underly performance on these two types of tasks. Six tests constructed to directly measure the intellectual processes of hypothesis generation (HG), hypothesis evaluation (HE), and memory for hypotheses (HM) were found to have factorial validity. The intellectual process measures were found to correlate highly with performance on several tests of mental abilities. An experimental manipulation of the information processing requirements of concept learning problems produced the predicted change in the relationship between concept learning problem performance and the profiles of scores obtained by Ss on the intellectual process measures. HG processing requirements in the concept learning task were manipulated by providing or not providing a short list of hypotheses, one of which was correct, to the Ss prior to the presentation of each of four concept learning problems. Four additional concept learning problems were worked by all Ss. None of the Ss received the list of hypotheses prior to the presentation of these problems. On problems 1 through 4, the concept learning scores of those Ss provided with the list of

hypotheses were more strongly related to their HE process measure scores than their HG process measure scores. For those Ss not given the list of hypotheses on problems 1 through 4, HG was more important to their concept learning performance. As expected, the difference in concept learning performance between Ss scoring high on HG and Ss scoring low on HG in the group not supplied with the hypothesis information was greater than the difference in concept learning performance between Ss scoring high on HG and Ss scoring low on HG in the group supplied with the hypothesis information.

A somewhat unusual characteristic of the stimulus materials used in both the intellectual process measures and the concept learning problems was the poorly defined nature of the stimulus dimensions. Unlike the stimulus population used by Bruner, et. al. (1967), the stimulus materials consisted of instances containing four alphabetic characters. Relevant hypotheses for the concept learning problems included: the instance contains the letter X, the instance contains one and only one vowel, and so forth.

The authors interpret the effects of their experimental manipulation as support for the premise that the postulated set of intellectual processes do underly performance on both tests of mental abilities and concept learning tasks. The apparent substantial theoretical implications of the hypo-sized processes rest on the assumption that these processes

are invariant across different stimulus populations.

If these intellectual processes actually are required in responding to mental ability tests and concept learning problems, then the performance on tests of intellectual processes and concept learning problems involving different stimulus materials should be related in the same general manner as that found by Costello and Dunham (1971) and Costello (1971). That is, using errors on the concept learning problems as a dependent variable, the following types of relationships should exist:

1. Ss supplied with hypothesis information should perform significantly better on concept learning tasks than Ss not supplied with such information.

2. There should be a significant treatment group by HG interaction.

3. There should be a significant HG by HE interaction.

If these relationships are found in stimulus domains other than that used in previous studies, corroborating evidence would be obtained to support the findings of Costello and Dunham (1971) and Costello (1971).

Methods

Subjects. 134 undergraduate students enrolled in an introductory educational psychology course at the University of Texas at Austin were administered six intellectual process measures. Fifty of these Ss were used in an attempt to develop an operational computer program to present the concept learning

problems. Due to technical difficulties the concept learning data on these Ss and this method of concept learning problem presentation were abandoned. The data of six additional Ss were dropped from the analysis because of the Ss' failure to comply with the instructions. For purposes of analysis, the data of only those Ss on whom complete data was obtained were used (N = 78).

Groups. Seventy-eight Ss who had completed the process measures were assigned in order of appearance alternately to one of two experimental groups: information on correct solution provided group (IP, N = 39); no information on correct solution provided group (NIP, N = 39). Each of the groups received identical concept learning problems and instructions except that the IP group received a "clue" about the correct hypothesis on each problem.

Process measures. One of each of the process measures used by Costello and Dunham (1971) and comparable process measures using numerical stimuli were administered to the Ss in group sessions. The HG tests contained one item. The Ss were instructed that their task was to list as many rules (hypotheses) for the item as possible. The HE measures consisted of several items followed by five hypotheses. Given the set of items, the Ss were required to indicate whether or not the hypotheses were correct. The memory test required the Ss to study a list of hypotheses each of which had a number

associated with it. The Ss then turned to the test page which contained 10 to 15 items and attempted to respond to each item by placing beside it the number of the hypothesis which applied to it. Four of the six tests in the battery were highly speeded. On each of the HG tests, ten minutes work time was allowed and this time appeared to be sufficient to consider it unspeeded since all of the Ss stopped working before the alloted time was exhausted. The total testing time for all tests was one hour.

Concept learning problems. All Ss worked two concept learning problems, each consisting of 100 trials. The concept learning problems were administered to the Ss individually and were self-paced with no time limit. The concept learning problem stimulus instances were presented sequentially by the S turning the cards in a problem deck. Each problem deck was arranged in a fixed random order. The front of each stimulus card contained an instance. The instance and its appropriate feedback were provided on the back of the card. The Ss responded to each instance by circling "yes" or "no" on a standardized answer sheet. The average working time on this task was one hour.

Each of the Ss worked one practice problem and one experimental problem. The correct solution to the practice problem was that a positive instance contained at least three numbers in consecutive serial order. The solution to the

experimental problem was that a positive instance contained one number which was the product of two of the other numbers in the instance.

For the IP group, the clue card for the practice problem contained the statement "the position of the numbers on the card is irrelevant, the rule involves numerical order." The clue card for the experimental problem contained the statement "the rule specifies a multiplicative relationship among the numbers."

Procedure. Two sessions, each approximately one hour long, on two different days were used to collect the test and concept learning data. In session one, the Ss were administered the intellectual process measures. In session two, the Ss received the concept learning problems. On reporting to the experimental room for session two, the Ss were assigned alternately to either group IP or NIP. Both groups received the same instructions regarding the nature of the stimuli, the nature of the task, the time allowed to work, and the response recording procedures.

The 100 trial practice problem deck and a standardized answer sheet were given to the S. Ss in group IP also received a card containing a clue. When the S completed a problem, he was given a sheet containing 10 hypotheses and he indicated which hypothesis he thought was correct for the problem just worked. The experimental problem was administered in the

same way.

Results

The scores of the six process measures were factor analyzed by the principal-axis method. Three factors were extracted and rotated to a Varimax criterion yielding the three postulated factors: hypothesis generation, hypothesis evaluation, and memory for hypotheses. The rotated factor matrix appears in Table 1. It should be noted that for each intellectual process, the Ss' scores for both stimulus domains (alphabetic and numerical) loaded on the same factor.

Insert Table 1 about here

A four between factorial analysis of variance on the total errors on the concept learning problem was computed. The independent variables in this analysis were defined in the following manner. Variable one represented the groups (IP and NIP). Variables two, three, and four each having two levels represented the three intellectual process measures as defined by the factor scores of each S. A median split defined low and high levels for each variable.

The results of the analysis of variance revealed a significant treatment main effect ($F = 19.21$; $df = 1, 15$; p .01) with total error score means of 8.61 (IP) and 20.60 (NIP). There was also a significant interaction between the

HE and HG variables ($F = 6.69$; $df = 1, 62$; p .05) This interaction is illustrated in Figure 1.

Insert Figure 1 about here

The expected treatment group by HG interaction was not significant ($F = .08$; $df = 1, 62$; .50 p .55).

Discussion

Failure to reject the null hypothesis, that is absence of a significant interaction between treatment group and HG, does not necessarily contradict the results of earlier studies. Considering the evidence from earlier studies, it seems more reasonable to conclude that the experimental manipulation used here produced a smaller effect. The experimental manipulation of this study was of a slightly different character from that which was used in earlier studies. In previous studies, a small number of possible hypotheses were provided (one of which was the correct solution) and the S merely had to isolate the correct one. In this study, information provided to the S eliminated some of the possible dimensions which might be used in generating hypotheses. Although both of these manipulations would appear to reduce the HG processing requirements in a concept learning task, the results suggest that the manipulation used in this study was not as successful as that used in earlier studies. The earlier treatment would

appear, on logical grounds, to essentially eliminate the HG processing requirements in the concept learning task. Having a list of hypothese known to contain the correct solution, the S need only evaluate these various hypotheses against the feedback and the stimulus information presented as the problem proceeds. Providing information limiting the set of possibly relevant stimulus dimensions reduces but does not eliminate the HG processing demands of the task. As was expected, however, the analysis does clearly indicate that the treatment in this study resulted in a significant difference between the two groups with respect to the total number of errors on the concept learning problem.

Theinteraction between performance on the HE and HG process measures indicates that performance on concept learning problems is not a simple function of the level of attainment on the process measures. High performance on the HG process measure is associated with improved concept learning performance if and only if there is a concommitant high performance on the HE process measure.

The results obtained tend to support the conclusion of earlier studies on the role of abilities in concept learning. Furthermore, the results tend to indicate that the earlier conclusions may be generalized to new stimulus content domains.

TABLE 1

ROTATED FACTOR MATRIX

TESTS	FACTORS		
	Hypothesis Generation (HG)	Hypothesis Evaluation (HE)	Memory for Hypotheses (HM)
HG Alphabetical Stimuli	.89	.18	-.03
HG Numerical Stimuli	.89	.06	.17
HE Alphabetical Stimuli	.15	.90	.19
HE Numerical Stimuli	.14	.80	.34
HM Alphabetical Stimuli	-.08	.33	.78
HM Numerical Stimuli	.25	.21	.84

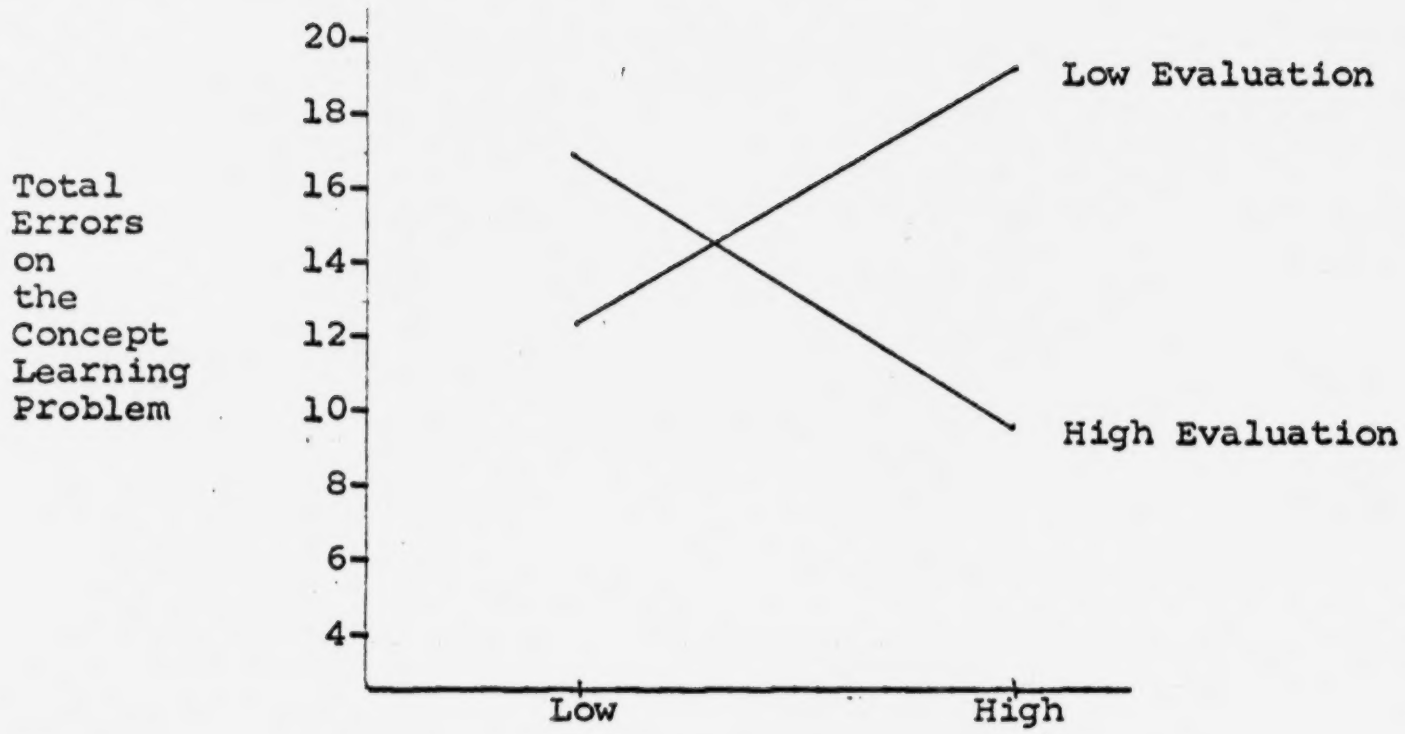

Figure 1. Graphic representation of the hypothesis generation and hypothesis evaluation interaction as computed in the analysis of variance of total error scores on the concept learning problem.

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